



Preliminaries to Erosion: Weathering and Mass Wasting

Chapter 15

Denudation

- The overall effect of the disintegration, wearing away, and removal of rock material
 - Types
 - Weathering – breaking down of rock into smaller components by atmospheric and biotic agencies
 - Mass Wasting – relatively short-distance down slope movement of broken rock material due to gravity
 - Erosion – more extensive and generally more distant removal, transportation and eventual deposition of fragmented rock material
-

Weathering & Rock Openings

- The **mechanical disintegration** and/or **chemical decomposition** that destroys the coherence of bedrock and begins to fragment rock masses into progressively smaller components
 - **Occurs when the lithosphere and atmosphere meet.**
-

Types of Rock Openings

- **Microscopic openings** – occur in profusion on a rock surface
 - **Joints** – cracks that develop as a result of stress but the rocks show no appreciable displacement parallel to the joint walls.
Most important in facilitating weathering
-

Types of Rock Openings

- **Faults** – breaks in bedrock along which there is relative displacement of the walls making up the crack. Difference between faults and joints, faults may run hundreds of feet or miles, where joints are normally only a few meters.
 - **Lava vesicles** –holes of various sizes, usually small that develop in cooling lava
 - **Solution cavities** – holes formed in calcareous rocks (particularly limestone) as soluble minerals are dissolved and carried away by percolating water.
-

The Importance of Jointing

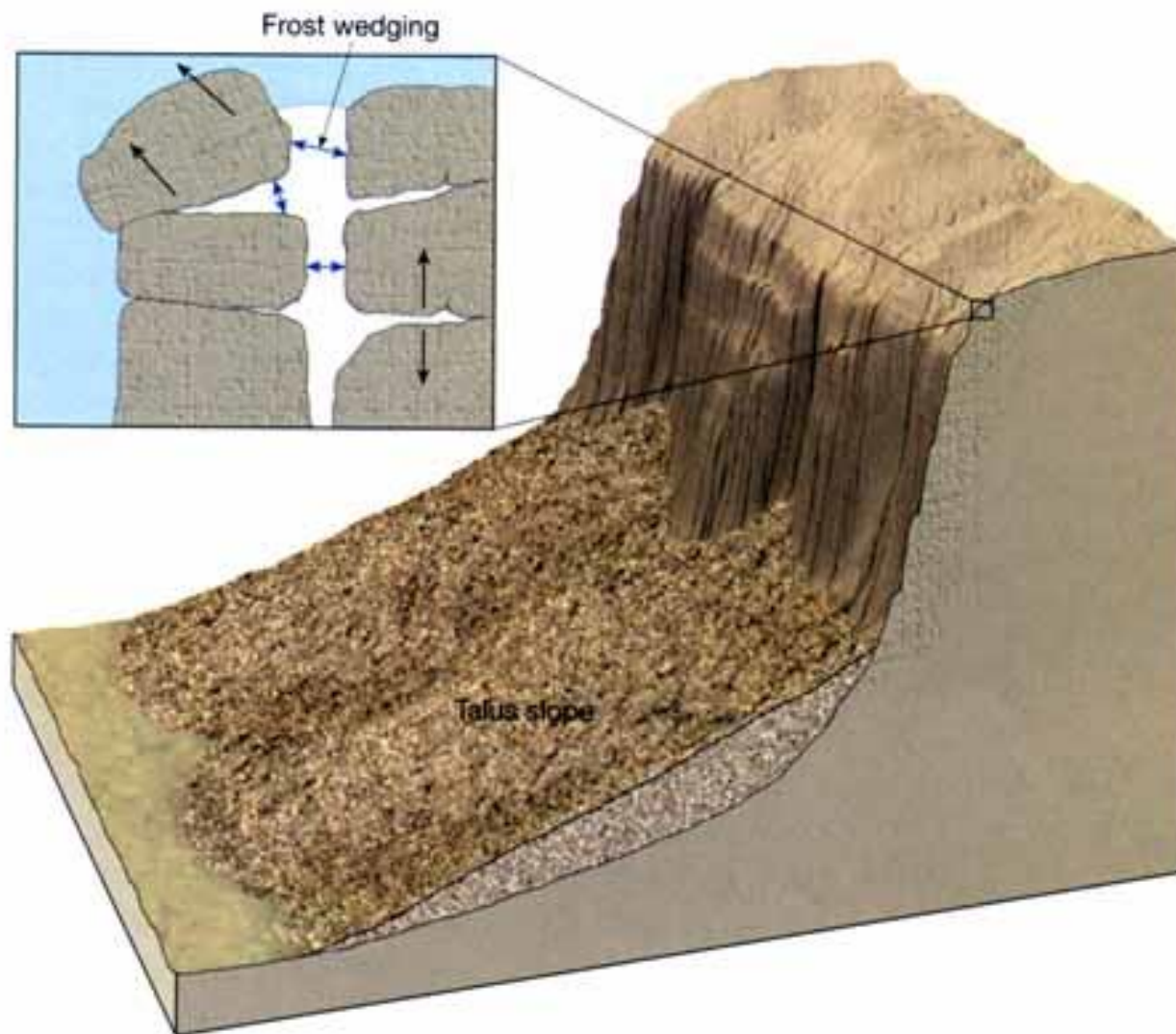
- Most bedrock is jointed
 - Joints are usually arranged in sets parallel to each other
 - Where sets intersect at right angles is called a *joint system*.
 - Master joints -- Large joints or joint sets extend long distances and through a considerable thickness of rock
 - Master joints function as a plane of weakness susceptible to weathering and erosion
-

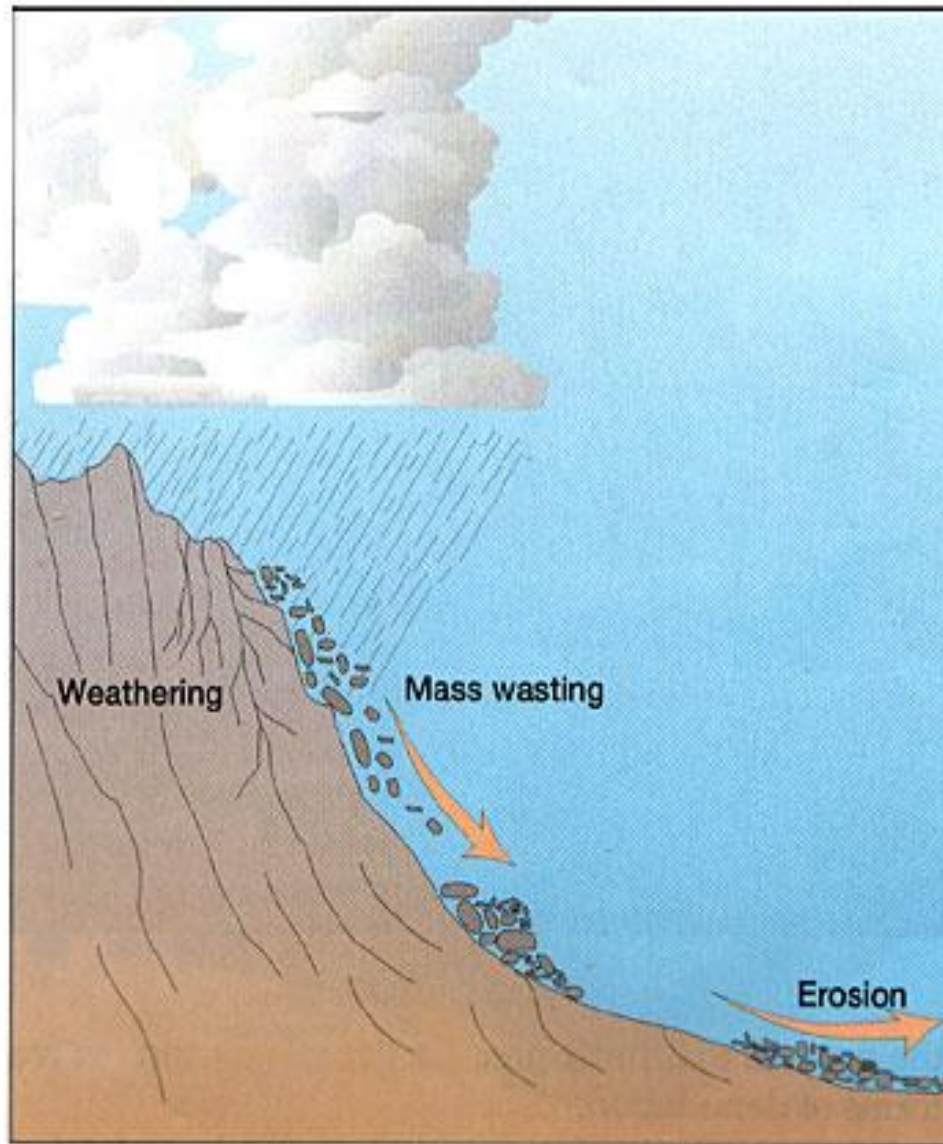
Weathering Agents

- **Three principal categories of weathering**
 - **Mechanical**— the physical disintegration of rock material without any change in its chemical composition
 - **Chemical**— the decomposition of rock by the chemical alteration of its minerals
 - **Biotic**— the process where animals and plants contribute to disintegration of rock material
-

Mechanical Weathering

- **Frost Wedging** – repetition of freeze/thawing of water in cracks of rocks
 - **Salt wedging** – happens in arid areas. Crystallized salt builds up from evaporated water in cracks, splitting the rock
 - **Temperature changes** – fluctuation of temperature from day to night or summer to winter causes minute expansion or contraction of the minerals in the rocks
 - **Exfoliation** – the processes where curved layers peel off bedrock: the stripping away of roughly parallel concentric rock slabs.
 - Exfoliation dome several partially fractured shells of the surface layers.
-





Low Risk

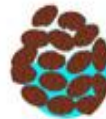


High Risk

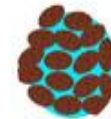
Pore
Water



Unsaturated



Partially Saturated



Saturated

Earth
Material



Sediment



Layered Rock



Igneous Rock

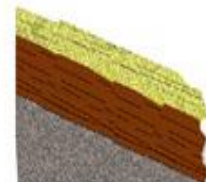
Rock
Orientation



Dips Upslope

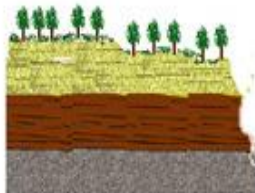


Horizontal

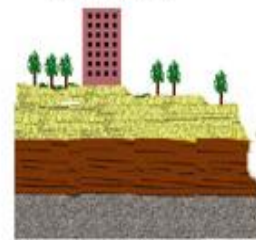


Dips Downslope

Vegetation



No Development



Moderate Development



Extensive Development

Chemical Weathering

- Mechanical weathering exposes bedrock to the forces of chemical weathering.
 - Most efficient and conspicuous in warmer climates where the chemical reactions work better
 - Oxidation – oxygen dissolved in water coming in contact with certain rock minerals
 - The combination of iron-bearing minerals in rocks produces iron oxide or “rust” on the rock.
 - Hydrolysis – the union of water with another substance to produce a new compound that is nearly always softer and weaker than the original
 - Carbonation – the reaction between the carbon dioxide in water forming carbonic acid producing a very soluble product
-

Biological Weathering

- Penetration of plant roots into cracks and crevices resulting in expanding the crack or breaking the rock
 - Lichens draw minerals from the rock weakening the rock, and also they get wet and then drying, flaking of tiny particles of rock
 - Burrowing animals mixing soil effectively which can be a factor in rock disintegration
-





Climate and Weathering

- Weathering is enhanced by a combination of high temperatures and abundant precipitation.
 - Moisture would be the most important
-

Mass Wasting

- The process whereby weathered material is moved a relatively short distance down slope under the direct influence of gravity.
 - Angle of Repose – the angle which cohesive layers of soil lie at rest on a slope if undisturbed unless the slope has a certain steepness.
 - Water -- a lubricating medium that can diminish the friction between particles allowing easier sliding.
 - Clay – readily absorbs water allowing a spontaneous change from relatively solid mass to a near-liquid condition as result of a sudden disturbance or shock
 - <http://earthsci.org/processes/geopro/massmov/massmov.html>
-

Types of Mass Wasting

- **Fall** -- simplest and most obvious form of mass wasting: when loosened by weathering on a very steep slope a rock fragment may simply be dislodged and fall, roll or bounce to the bottom of that segment of slope
- **Results of a Fall**
 - Talus or scree — debris of the fall
 - Talus cones -- mounds of debris at the bottom of a fall



Rock fall

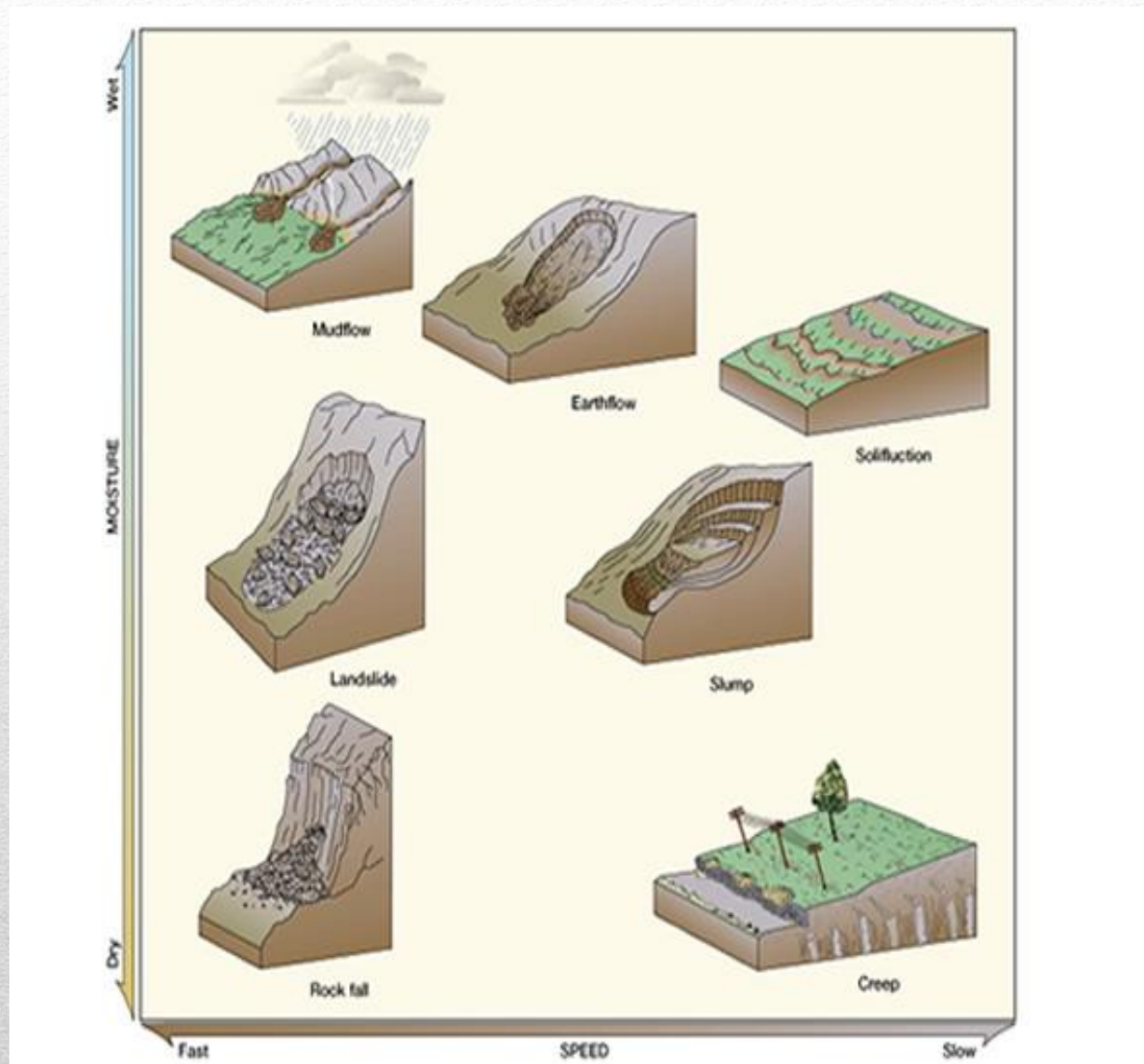
Mass Wasting

Talus Slopes



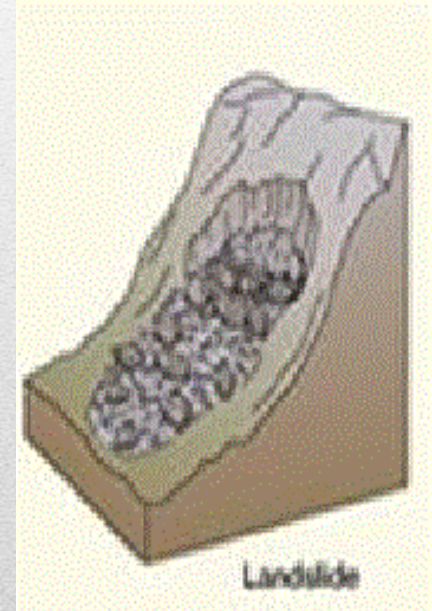
Unloading Slopes





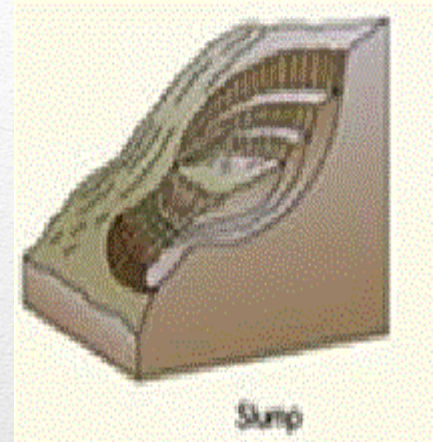
Types of Mass Wasting

- Slide – an instantaneous collapse of a slope (a type of slope failure) and does not necessarily involve the lubricating effects of water or clay.
- Results topographically result of a **landslide**
 - On the hill where the slide originated, there is a deep extensive scar
 - In the valley bottom where the slide material comes to rest a massive pile of highly irregular debris
 - On the up-valley side of the debris, a lake may form



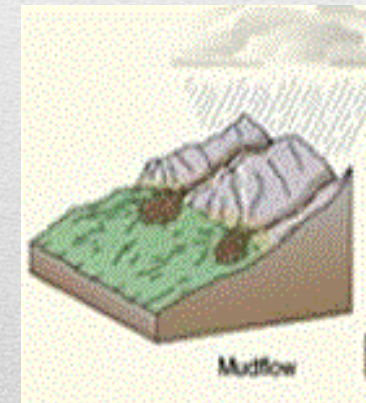
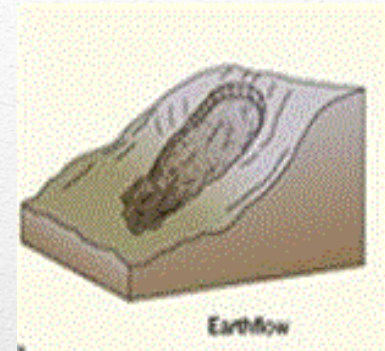
Types of Mass Wasting

- **Slump** – involves slope failure in which the rock or regolith moves downward and at the same time rotates outward along a curved slide plane that has its concave side facing upward.
- **Flow** a sector of a slope becomes unstable, normally owing to the addition of water, and flows gently downhill. Some cases the mass moves more rapidly than the base and the sides.



Types of Mass Wasting

- **Earthflow** – a portion of a water-saturated slope moves a limited distance downhill, normally during or immediately after a heavy rain.
- **Mudflow** – originates in drainage basins in arid and semiarid country when a heavy rain following a long dry spell produces a cascading runoff too voluminous to be absorbed into the soil.
 - **Debris flow** -- debris carried by the mudflow, causing much damage



Types of Mass Wasting

- Creep – consists of a very gradual downhill movement of soil and regolith of unobtrusive that it can normally be recognized only by indirect evidence.
- Caused by the interaction of various factors most significant being alternation of freeze-thaw and wet-dry conditions.
- Very slow process. Can leave hillside ridges – *terraces*.

